Code No: RR410306 **Set No. 1**

IV B.Tech I Semester Regular Examinations, November 2006
JET PROPULSION AND ROCKET ENGINEERING
(Mechanical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) What do you understand by a closed cycle gas turbine, what difficulties are encountered in the development of closed cycle plant.
   (b) Sketch and explain simple cycle with inter cooling and reheating. Draw P-v and T-s diagrams of the cycle. [8+8]

2. (a) Explain the principle of jet propulsion and how you determine the thrust.
   (b) Explain clearly the various efficiencies associated with propulsion devices. [8+8]

3. A turbojet air craft is flying at 800 km/hr at an altitude where the pressure is 0.25 bar and temperature is -4^0 C. The pressure ratio in the compressor is 10:1 and the maximum cycle temperature is 800^0C. Calculate the thrust developed and specific fuel consumption. Assume the following data : isentropic efficiency of compressor = 90% Total head pressure loss in the combustion chamber = 0.15 bar, calorific value of fuel = 40200 KJ/hr combustion efficiency = 98%, isentropic efficiency of Turbine = 92% and Jet Nozzle = 94%, nozzle outlet area = 800 cm^2. The nozzle in the turbojet is convergent. [16]

4. (a) Describe the working of a ramjet engine.
   (b) Depict the various thermodynamic processes occurring in it on h-S diagram.
   (c) What is the effect at flight mach number on its efficiency. [8+4+4]

5. (a) What are the requirements of an ideal rocket propellant?
   (b) Derive the equation for calculation of effective jet velocity in rocket? [8+8]

6. What are different types of liquid propellants used in rocket engines? How these fuels can be combined as bipropellants? [16]

7. (a) Describe briefly three important applications of rocket propulsion.
   (b) What is the purpose of injectors in rocket engines? Describe an injector with the aid of sketch. [4+12]

8. (a) With the help of a neat diagram, explain the working of liquid bi-propellent gas pressurization system.
   (b) Discuss the possibility of rocket-powered vehicle having a flight velocity greater than the exhaust velocity of the rocket motor. [8+8]

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Code No: RR410306 **Set No. 2**

IV B.Tech I Semester Regular Examinations, November 2006
JET PROPULSION AND ROCKET ENGINEERING
(Mechanical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. Calculate the efficiency and specific workout of a simple gas turbine plant operating on Brayton cycle the max and min temperatures are 1000 K and 288 K respectively. The pressure ratio is 6, the isentropic efficiencies of the compressor and turbine are 85 and 90% respectively. If the unit consumes 2 tons of oil per hour of C.v. 46,500 kJ/kg. Determine the power generated the mechanical efficiency is 90% and the generator efficiency is 85%. [16]

2. What is meant by thrust? Derive the thrust equation for a general propulsion system. Explain the effective jet exit velocity, thrust power and propulsive power. [16]

3. A Turboprop engine operates an aircraft at an altitude of 3000 meters above mean sea level at a speed of 525 kmph. The data for the engine is given below.
   Inlet diffuser efficiency $= 0.875$
   Compressor efficiency $= 0.790$
   Velocity air at compressor entry $= 90$ m/s.
   Temperature rise through the compressor $= 230^0C$
   Properties of air : $\gamma = 1.4$, $C_P = 1.005$ KJ/Kg K.
   From the above data calculate.
   (a) Pressure rise through the inlet diffuser
   (b) Pressure ratio developed by the compressor
   (c) Power required by the compressor per unit flow rate of air and
   (d) The air standard efficiency of the engine. [16]

4. A ramjet engine operates at M=1.5 at an altitude of 6500 m. The diameter of the inlet diffuser at entry is 50 cm and the stagnation temperature at the nozzle entry is 1600 K. The calorific value of the fuel is 40 MJ/Kg. The properties of the combustion gases are same as those of air ($\gamma = 1.4$, R = 287 J/KgK). The velocity of air at the diffuser exit is negligible. Calculate
   (a) the efficiency of ideal cycle
   (b) flight speed
   (c) air flow rate
   (d) diffuser pressure ratio
   (e) fuel air ratio
   (f) nozzle pressure ratio

(g) nozzle jet mach number

(h) propulsive efficiency and

(i) thrust. Assume the following values $\eta_D = 0.9$, $\eta_s = 0.98$, $\eta_j = 0.96$, stagnation pressures loss in the combustion chamber = 0.02 P_{02}. [16]

5. Write short notes on the following terms:

(a) Thrust

(b) specific thrust

(c) specific impulse

(d) specific propellant consumption. [16]

6. (a) What are the difference between bipropellant and monopropellants used in rocket engines?

(b) How the liquid bipropellants are prepared for the rocket engines? [8+8]

7. (a) Draw a simple sketch of multi stage rocket vehicle depicting clearly the booster stage, propellant tanks and exhaust nozzle, instruments and navigational equipment.

(b) Explain briefly the meaning of the following.

i. Booster rocket stage

ii. Sustainer stage

iii. Retro Rocket. [10+6]

8. (a) With the help of a neat diagram, write about nuclear rocket engine.

(b) What are the advantages it has over other rocket engines. [8+8]

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Code No: RR410306 **Set No. 3**

IV B.Tech I Semester Regular Examinations, November 2006
JET PROPULSION AND ROCKET ENGINEERING
(Mechanical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. With the help of neat schematic explain the simple gas turbine system with regeneration, inter cooling and reheating. Show the process on p-v and T-s diagrams. [16]

2. (a) Explain the principle of jet propulsion and mention how the jet propulsion engines are classified.
   (b) The effective jet velocity from a jet engine is 2700 m/sec. The forward flight velocity is 1350 m/sec and the air flow rate is 78.6 kg/sec. Calculate
      i. thrust
      ii. thrust power
      iii. Propulsive efficiency. [8+8]

3. A turbojet engine propels an aircraft at a mach number of 0.8 in level at an altitude of 10 km. The data for the engine is given below stagnation temperature at the turbine inlet = 1200 k stagnation temperature rise through the compressor = 175 K, Calorific value of fuel = 43
   MJ/kg.Compressor efficiency = 0.75
   Combustion chamber efficiency = 0.975
   Turbine efficiency = 0.81
   Mechanical efficiency of the power transmission between turbine and compressor = 0.98
   Exhaust nozzle efficiency = 0.97
   Specific impulse = 25 seconds
   Assuming the same properties for air and combustion gases calculate.
   (a) fuel - air ratio
   (b) compressor pressure ratio
   (c) Turbine pressure ratio
   (d) Exhaust nozzle pressure ratio
   (e) Mach number of exhaust jet. [16]

4. (a) Describe the working of a ramjet engine.
   (b) Depict the various thermodynamic processes occurring in it on h-S diagram.
   (c) What is the effect at flight mach number on its efficiency. [8+4+4]

5. (a) Explain the essential differences between rocket propulsion and turbojet propulsion?

(b) What is the importance of specific impulse in rocket engines? [8+8]

6. (a) Compare liquid propellant rocket engine with solid propellant rocket engine?
   (b) What are different applications of solid propellant rocket engines? [8+8]

7. (a) Define the following quantities, write down their formulae and units: specific impulse, total impulse, and specific propellant consumption.
   (b) Calculate thrust, specific impulse, propulsive, thermal and overall efficiencies of a rocket engine from the following data:
   Effective jet speed = 1250m/s.
   Flight to jet speed ratio = 0.80
   Oxidizer flow ratio = 3.5 kg/s
   Fuel flow rate = 1.0 kg/s
   Heat of reaction per kg of exhaust gases = 2500 KJ/kg. [8+8]

8. (a) With the help of a neat diagram, write about nuclear rocket engine.
   (b) What are the advantages it has over other rocket engines. [8+8]

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Code No: RR410306 **Set No. 4**

IV B.Tech I Semester Regular Examinations, November 2006
JET PROPULSION AND ROCKET ENGINEERING
(Mechanical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. A Brayton cycle operates with ideal air between 1 bar, 300 k and 5 bar 1000 k. The air is compressed in two stages with perfect intercooling. Similarly in the turbine expansion occurs in two stages with perfect reheating.
   (a) What is the optimum pressure in bar
   (b) What is the net work output
   (c) What fraction of the turbine output has to be put back to compressor. [16]

2. (a) What is the principle of working of Thermal jet engines and their classification.
   (b) Derive an expression for Propulsive efficiency of Thermal jet engine. [8+8]

3. An Aircraft flies at 960 kmph. One of the its turbojet engines takes in 40 kg/s of air and expands the gases to the ambient pressure. The air fuel ratio is 50 and the lower calorific value of the fuel is 43 MJ/Kg. For maximum thrust power determine
   (a) Jet velocity
   (b) thrust
   (c) specific thrust
   (d) thrust power
   (e) propulsive, thermal, overall efficiencies and TSFC. [16]

4. (a) Describe the working of a ramjet engine.
   (b) Depict the various thermodynamic processes occurring in it on h-S diagram.
   (c) What is the effect at flight mach number on its efficiency. [8+4+4]

5. (a) Explain the working of nuclear rocket engines?
   (b) What are the important parameters to evaluate the performance of a rocket engine? Explain. [8+8]

6. What are different types of rocket propellants? How the liquid bipropellants are prepared? What are different possible combinations of fuels? [16]

7. (a) Derive an expression for the velocity of a rocket vehicle at the end of the powered flight.
   (b) What is the effect of mass ration, specific impulse and burnout time on the maximum velocity attained by the rocket-vehicle? [6+10]

8. (a) With the help of a neat diagram, write about nuclear rocket engine.
   (b) What are the advantages it has over other rocket engines. [8+8]

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